
TECHNICAL MEMORANDUM

To: Ray Cody and Karen Simpson, United States Environmental Protection Agency, Region 1
From: Matt Lundsted and Nick Cristofori, CEI and Ken Hickey and Bruce Jacobs, WaterVision
Subject: **Task 1 Summary Memo: A description of recently completed data collection, conceptual design, and associated tasks.**
Date: January 9, 2015

This memo provides a summary of tasks completed to date as part of the United States Environmental Protection Agency (EPA) project entitled; *Design and Construction of a Green Infrastructure Stormwater BMP Retrofit for One or More Municipal Properties on Cape Cod: A Demonstration and Education and Outreach Project*. We have completed the following preliminary tasks to date:

1. Chatham Site - Data collection and conceptual designs for a potential stormwater BMP;
2. Barnstable Site - Data collection and conceptual designs for a potential stormwater BMP;
3. Assessment of permitting requirements associated with the two sites;
4. Recommendations for in-kind services to be provided by the municipalities; and
5. Assessment of the monitoring program design.

Each of these tasks is describe below. This work is being conducted by Water Vision, LLC and Comprehensive Environmental, Inc. (CEI), referred to herein as the Design Team. Please note that a brief literature and technology review of nitrogen-removal stormwater BMPs has also been conducted and will be summarized in a separate technical memorandum.

1. Chatham BMP Site

Kickoff Meeting

On October 23, 2014, a kickoff meeting was conducted in the Town of Chatham to discuss a potentially suitable BMP site at the intersection of Oyster Pond Furlong and Absegami Run in Chatham (Figure 1). This meeting was attended by Robert Duncanson (Chatham), Johanna Hunter, Ray Cody, and Karen Simpson (EPA), Ken Hickey and Bruce Jacobs (WaterVision), and Matt Lundsted and Nick Cristofori (CEI). The kickoff meeting consisted of a sit-down meeting at the town offices followed by a visit to the proposed BMP site. Dr. Duncanson is the Storm Water Management Program Coordinator for the Town of Chatham and assured the group that Chatham would be fully supportive of a BMP demonstration project.

BMP Site Overview

The potential BMP site is situated in Chatham, near the “elbow” of Cape Cod (Figure 1). The proposed BMP would divert stormwater from a trunk line that drains approximately 16.9 acres that could be intercepted according to information provided by the Town of Chatham. An estimated 5.7 acres of the drained area is impervious. The stormwater network currently discharges at an outfall within the Oyster Pond estuary. The potential BMP at this site has been tentatively named the Oyster Pond BMP.

The Oyster Pond BMP site location was observed to be heavily overgrown and located within a depression approximately ten feet below the adjacent roadways. Although the overall undeveloped parcel is large in size, a large portion is occupied by a drainage ditch and associated wetland areas. As a result, the available area for the BMP is limited to a relatively small parcel near the intersection of Oyster Pond Furlong and Absegami Run. There are numerous underground utilities along Oyster Pond Furlong, including water, gas, and a new sewer line.

A 24-inch diameter drainage trunk line reportedly runs down Oyster Pond Furlong. For the Oyster Pond BMP, the trunk line would be intercepted and a portion of stormwater flow would be directed into a stormwater BMP at this site.

Field Data Collection and Analysis

On December 10, Soil Exploration Corp. of Leominster, Massachusetts drilled two on-site soil borings at the Oyster Pond BMP site. A groundwater monitoring well was also installed so that depth to groundwater could be monitored as needed during the coming months. Prior to performing onsite geotechnical investigations, the Town of Chatham marked for DigSafe and performed limited site clearing to create access pathways for drilling equipment. The Design Team then coordinated with DigSafe at least 72 hours in advance of conducting work at the site.

Soil borings were advanced to a depth of approximately 12-feet below grade. Soils at the Oyster Pond BMP site were found to be generally loose, fine sand with some silt. Soil borings revealed a shallow groundwater table, approximately one foot below the surface of the ground. However, the days prior to the measurement of depth to water had seen approximately two to three inches of rain fall over the area, likely contributing to an artificially high groundwater table. Based on previously completed soil borings near the Oyster Pond BMP site, it is estimated that typical groundwater depths are approximately two feet below the level measured in the field.

Based on these findings, we recommend that the Oyster Pond stormwater BMP design include an impermeable membrane lining on the bottom and sides to ensure horizontal subsurface flow, maximize treatment capabilities and minimize potential contact between groundwater and stormwater.

Copies of soil borings obtained at the Oyster Pond BMP site are included as **Attachment A** to this Summary Memorandum.

Conceptual Design

After the kickoff meeting, the Town of Chatham provided the Design Team with available site information, including watershed delineation and sizes, limited survey information, drainage network connectivity with elevations, and property ownership records. The Design Team has incorporated available information into a preliminary conceptual design for the Oyster Pond BMP.



A surface gravel wetland is proposed for the Oyster Pond BMP site. The proposed gravel wetland treatment system has been designed to accommodate 0.3 inches of runoff over the contributing impervious area. Ideally, a gravel wetland would be sized to accommodate the water quality volume (WQV), defined as 1-inch of runoff over the contributing impervious area, however there is insufficient space to enable that level of treatment at this site. Space at the site is limited due to a combination of regulated resource areas and existing grades. As noted by the UNH Stormwater Center, “the majority of nitrogen washoff in parking lots occurs with the first 0.3-inch of precipitation” (Gunderson et al., 2012). Therefore, this stormwater BMP has been designed to treat a minimum of 0.3-inches of runoff from the contributing impervious area.

Figure 2 provides a map of the preliminary Oyster Pond BMP design with infrastructure, resource areas, and slopes indicated. Figure 3 provides a cross-section view of the conceptual BMP with a description of the stormwater treatment process. The general design components are as follows:

- Pretreatment sediment forebay approximately 3-feet deep and capable of holding in excess of 10% of the water quality volume. Additionally, two gravel wetland cells approximately 3-feet deep will be constructed, each capable of holding in excess of 0.15-inches of runoff over the impervious area;
- The trench fill will consist of 24 inches of crushed stone, topped by 6 inches of smaller pea stone and 8 inches of loam / wetland soil mix capable of supporting plant life;
- The gravel wetland cells and the sediment forebay will be interconnected with subsurface pervious piping systems to achieve lateral water flow through the BMP. This will convey water from aerobic conditions in the first cell to anerobic conditions in the second cell;
- The sediment forebay and bioretention cells will be lined on the sides and bottoms with an impervious liner to eliminate contact between stormwater and groundwater. Additionally, a perimeter drain will be installed around a portion of the stormwater BMP to help dewater the area;
- A 10-foot wide construction access and maintenance road with access off of Absegami Run will be constructed. The road will surround the sediment forebay on three sides to facilitate sediment removal, and provide access along the east side of the gravel wetland cells;
- To feed the gravel wetland, a new pipe will be cut into an existing manhole (MH #1) at the intersection of Oyster Pond Furlong and Absegami Run. The pipe will be routed into a new drainage manhole just off the edge of pavement before discharging via a flared end section onto a riprap pad in the sediment forebay;
- A diversion wall will also be constructed within the existing manhole to direct low flows into the stormwater BMP while allowing storms exceeding BMP capacity to bypass through the existing drainage trunk line down Oyster Pond Furlong;
- Overflow from the second gravel wetland cell will be controlled by an outlet structure, capable of releasing water into the adjacent wetland resource area. The overflow structure, combined with the lined basins will serve to always maintain a water level within the underlying gravel layer to maintain horizontal subsurface flow paths and anaerobic conditions suitable for nitrogen removal; and



- An emergency riprap overflow level spreader will be installed in the second wetland cell, capable of bypassing stormwater in excess of the outlet structure capacity.

An Oyster Pond stormwater BMP, as shown in Figures 2 and 3 and described above, appears feasible at this location, based on available information. Conceptual design and supporting calculations are included as **Attachment B** to this Summary Memorandum.

2. Barnstable BMP Site

Kickoff Meeting

On October 23, 2014, a kickoff meeting was conducted in the Town of Barnstable to discuss a potentially suitable BMP site at the intersection of South Street and Pleasant Street in Hyannis, a city within the Town of Barnstable (Figure 4). This meeting was attended by Roger Parsons, Dale Saad, Robert D. Golden (Barnstable), Johanna Hunter, Ray Cody, and Karen Simpson (EPA), Ken Hickey and Bruce Jacobs (WaterVision), and Matt Lundsted and Nick Cristofori (CEI). The kickoff meeting consisted of a sit-down meeting at the town offices followed by a visit to the proposed BMP site. The Town of Barnstable officials assured the group that Barnstable would be fully supportive of a BMP demonstration project.

Site Overview

The potential BMP site is situated in Hyannis (Figure 4). The proposed BMP would divert and treat stormwater from a 24-inch diameter drainage trunk line that runs north to south adjacent to the site. The trunk line drains approximately 6.9 acres that could be intercepted (according to the information provided by the Town of Barnstable), with an estimated 3.5 acres of impervious area. The stormwater line currently discharges to Hyannis Inner Harbor in the Gateway Marina area. The potential BMP at this site has been tentatively named the Gateway Marina BMP.

The Gateway Marina BMP site was observed to be a relatively flat open space adjacent to a pleasant pedestrian walkway. Although small in size, the site is ideally suited as a public demonstration project because public access is already in place. There are numerous underground utilities present along South Street, including water, gas, sewer and telephone. For the Gateway Marina BMP, the drain line would be intercepted and a portion of the stormwater flow would be directed into a stormwater BMP at the site.

Field Data Collection and Analysis

On December 10, Soil Exploration Corp. of Leominster, MA drilled two on-site soil borings at the Gateway Marina BMP site. A groundwater monitoring well was also installed so that depth to groundwater could be monitored as needed during the coming months. Prior to performing onsite geotechnical investigations, the Town of Barnstable marked for DigSafe. The Design Team then coordinated with DigSafe at least 72 hours in advance of conducting work at the site.

Soil borings were advanced to a depth of approximately 12-feet below grade. Soils at the Gateway Marina BMP site were found to be loose and varied between gravel, sand, silt, and peat. These soils are likely representative of a mixture of native soil and fill materials associated with prior construction at the site. Soil borings revealed a shallow groundwater table, approximately one foot below the surface



of the ground. The measured depth to water may be atypical since the area had recently received two to three inches of rain.

Based on these findings, we recommend that the Gateway Marina stormwater BMP design include an impermeable membrane lining on the bottom and sides to ensure horizontal subsurface flow, maximize treatment capabilities and minimize potential contact between groundwater and stormwater.

Copies of soil borings obtained at the Gateway Marina BMP site are included as **Attachment A** to this Summary Memorandum.

Conceptual Design

After the kickoff meeting, the Town of Barnstable provided the Design Team with available site information, including watershed delineation and sizes, limited survey information, drainage network connectivity with elevations, and property ownership records. The Design Team has incorporated available information into a preliminary conceptual design for the Gateway Marina BMP.

A subsurface gravel wetland is proposed for the Gateway Marina BMP site adjacent to the pedestrian walkway area near the intersection of South Street and Pleasant Street. The proposed subsurface gravel wetland treatment system has been designed to accommodate 0.3 inches of runoff over the contributing impervious area. Standard design practice for subsurface gravel wetland would be to size the wetland to accommodate the water quality volume (WQV), defined as 1-inch of runoff over the contributing impervious area. There is insufficient space to provide for the full 1-inch of runoff over the contributing impervious area within a subsurface gravel wetland at this site. As noted by the UNH Stormwater Center, “the majority of nitrogen washoff in parking lots occurs with the first 0.3-inch of precipitation” (Gunderson et al., 2012). Therefore, this stormwater BMP has been designed to treat a minimum of 0.3-inches of runoff from the contributing impervious area.

Figure 5 provides a map the preliminary Gateway Marina BMP design with infrastructure and slopes indicated. Figure 6 provides a cross-section view of the preliminary BMP with a description of the stormwater treatment process. The general design components are as follows:

- The gravel wetland will consist of two cells situated adjacent to each other. The first cell will be located aboveground and provide aerobic conditions for nitrogen removal. The second cell will be located underground and will provide anaerobic conditions for nitrogen removal.
- Each cell will be filled with 24 inches of crushed stone, topped by 6 inches of smaller pea stone and 8 inches of loam / wetland soil mix. Combined, both cells will be capable of holding in excess of 0.30-inches of runoff over the contributing impervious area;
- Gravel wetland cells will be interconnected with subsurface piping systems to achieve lateral water flow through the BMP. This will convey the water from aerobic conditions in the first cell to anaerobic conditions in the second cell;
- The bioretention cells will be lined on the sides and bottoms with an impervious liner to eliminate contact between stormwater and groundwater.
- To feed the gravel wetland, a new manhole will be cut into the existing pipe that runs perpendicular to the foot path. The manhole will then discharge via a flared end section onto a riprap pad in the first gravel wetland cell;



- A diversion wall will also be constructed within the new manhole to direct low flows into the stormwater BMP while allowing storms exceeding BMP capacity to bypass through the existing line into the harbor. Limited surcharging of the existing drainage system will be required in order to limit the surface depth of the proposed BMP to approximately two feet; and
- Overflow from the subsurface gravel wetland will be controlled by a new outlet structure that is capable of releasing water into the adjacent existing stormwater pipe. The overflow structure will serve to always maintain a water level within the underlying gravel layer. This will ensure the maintenance of horizontal subsurface flow paths and anaerobic conditions suitable for nitrogen removal.

A Gateway Marina stormwater BMP, as shown in Figures 5 and 6 and described above, appears feasible at this location, based on available information. Conceptual design and supporting calculations are included as **Attachment B** to this Summary Memorandum.

3. Assessment of Permitting Requirements

At the Oyster Pond BMP site, most of the work would take place immediately adjunct to bordering vegetated wetlands (BVW) including within the 100-foot buffer zone, with very limited, localized impacts to the BVW itself associated with the emergency overflow and bypass pipe. Therefore, a Notice of Intent (NOI) should be filed with the Chatham Conservation Commission to permit proposed construction. This permitting task could be performed as an in-kind service by the Town (see Section 4 below). Permitting at the Oyster Pond site is not expected to substantially impact project costs. In terms of timing, the permitting process should begin in February 2015 using the best plans available in order obtain permits and to maintain the current project schedule. If permitting of the Oyster Pond site should prove unattainable, then construction at this location would be infeasible.

At the Gateway Marina BMP site, the proposed BMP appears to be located outside of resource areas and buffer zones. Therefore, permitting does not appear to be necessary for the Gateway Marina BMP site.

Additional street opening permits may be required by one or both towns to perform trenching work associated with new drainage pipe. Street opening permit requirements should be determined in the near future. This task could also be performed as an in-kind service by the Town (see Section 4 below).

4. Potential In-kind Services

In-kind services can help foster partnerships between stakeholders and expedite stormwater BMP construction. The Towns of Chatham and Barnstable have already provided some in-kind services and have expressed interest in offering additional in-kind services to help ensure project success. During the October through December 2014 time period, both communities provided services to EPA and the Design Team, including:

- Providing limited vegetation clearing, removal, and disposal;
- Identifying relevant local bylaws regarding permitting requirements; and



- Provide available site information, including storm drain as-builts and detailed watershed delineation.

It would be very beneficial if the municipalities could provide the following additional in-kind services to support the BMP demonstration projects:

- Provide basic BMP monitoring and sampling;
- Provide assistance with stormwater system access for sampling to confirm absence of illicit discharges;
- Provide Long-term Operation and Maintenance (O&M) of BMP;
- Provide permitting representation before the local Conservation Commission regarding compliance with Wetlands Protection Act (WPA);
- Assist with other Town permits, such as street opening, if applicable;
- Provide outreach assistance to coordinate with neighborhood associations for site access;
- Identify critical property and/or features of concern;
- Assume lead role in public outreach,
- Provide control and access to construction areas, including traffic management;
- Assist with materials management, including stockpile and reuse of excavated materials;
- Provide electrical service (115V) for monitoring shed; and
- Fencing of sloped area(s) if needed.

We recommend meeting with municipal officials and seeking the in-kind services outlined above.

5. Monitoring Program Design

The monitoring program design outlined in the WaterVision technical response of September 15, 2014 remains valid and suitable to serve as a basis for monitoring program design. We recommend modifying the monitoring program schedule to allow the proposed BMP treatment systems to become fully functional before monitoring is to begin. Gravel wetland and subsurface gravel wetland system depend on bacteria and other microbes to reduce nitrogen and other pollutant loads. The microbes require a significant amount of time (e.g., two or more seasons), from construction and “seeding” to full functionality in removing nitrogen and other pollutants. It would be unfortunate to expend resources (time and funds) monitoring gravel wetland BMP system performance before the system becomes fully functional. Therefore we recommend delaying the initial monitoring time to allow for that to occur.

The stormwater BMPs are scheduled to be constructed in the spring to early summer 2015 time period. We recommend commencing the monitoring program in the spring of 2016 to ensure in the BMP is fully functional throughout the duration of the monitoring program



Reference

J. Gunderson, R. Roseen, T. Ballestero, A. Watts, J. Houle, and K. Farah, Subsurface Gravel Wetlands for Stormwater Management. November 12, 2012.

List of Attachments

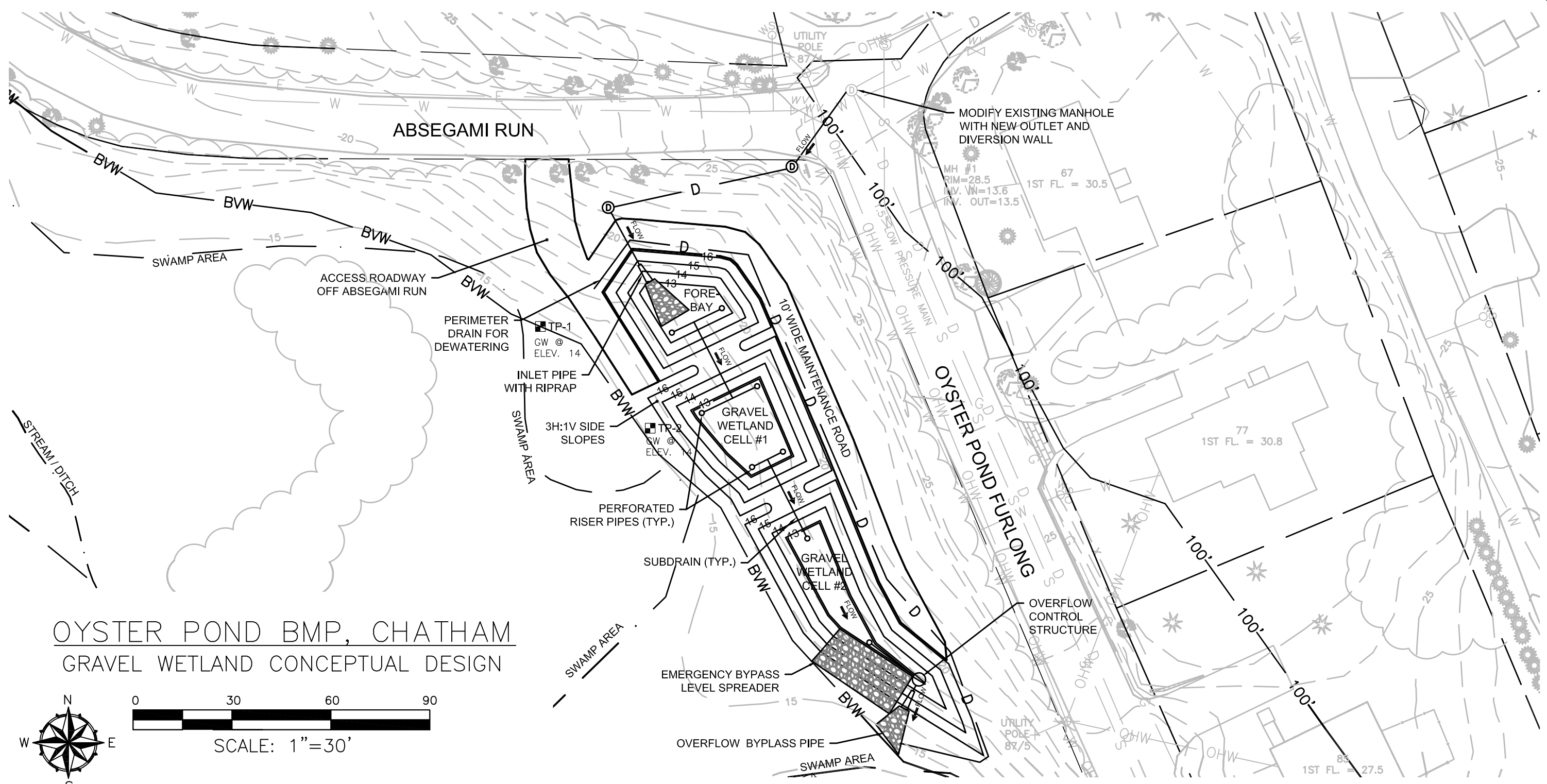
The following supporting information is included as attachments to this Summary Memorandum:

- Attachment A – Soil Boring Logs
- Attachment B – Conceptual Design Calculations

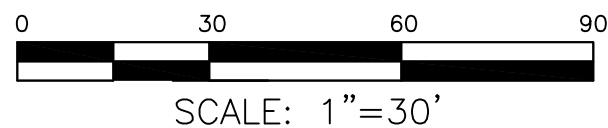
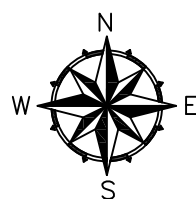




Figure 1. Potentially-suitable stormwater BMP site near Oyster Pond, Chatham



OYSTER POND BMP, CHATHAM GRAVEL WETLAND CONCEPTUAL DESIGN



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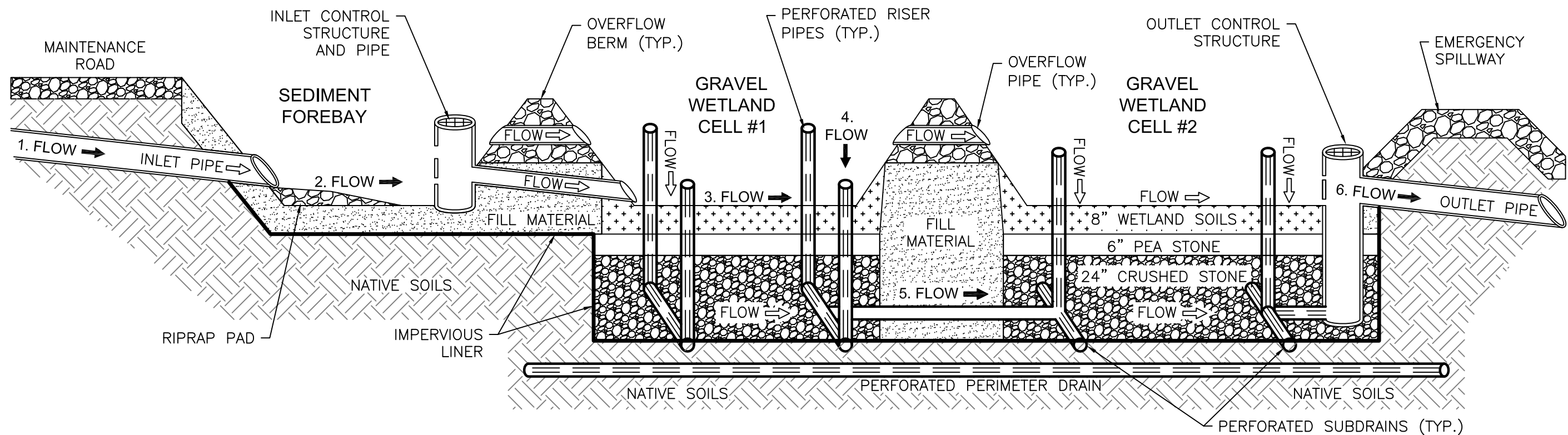


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**OYSTER POND BMP,
GRAVEL WETLAND**
Oyster Pond Furlong and
Absegami Run, Chatham MA

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**Figure
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OYSTER POND BMP, CHATHAM GRAVEL WETLAND CONCEPTUAL DESIGN

NOTE: SHOWN AT APPROXIMATE SCALE OF 1H:5V

STORMWATER TREATMENT PROCESS

- STEP 1:** A DIVERSION WEIR IS CONSTRUCTED IN THE EXISTING MANHOLE TO DIVERT SMALL STORMS INTO THE NEW STORMWATER BMP WHILE LARGER STORMS FLOW OVER THE WEIR INTO THE EXISTING DRAINAGE SYSTEM, BYPASSING THE BMP.
- STEP 2:** DIVERTED STORMWATER FLOWS INTO THE SEDIMENT FOREBAY FOR PRETREATMENT. SEDIMENT SETTLES OUT AND CONCENTRATES INTO ONE LOCATION, MAKING MAINTENANCE EASIER.
- STEP 3:** STORMWATER FLOWS INTO THE FIRST GRAVEL WETLAND CELL WHERE STORMWATER IS EXPOSED TO AEROBIC BACTERIA FOR AEROBIC NITROGEN CONVERSION AND REMOVAL. PLANT MATTER PROVIDES FURTHER NUTRIENT UPTAKE THROUGH THE ROOT SYSTEMS.
- STEP 4:** STORMWATER PERCOLATES THROUGH THE PLANT ROOT SYSTEM AND WETLAND SOILS OR IS COLLECTED IN PERFORATED RISER PIPES AND IS CONVEYED TO AN UNDERLYING GRAVEL LAYER WHERE ANAEROBIC BACTERIA PROVIDE NUTRIENT REMOVAL VIA CONVERSION OF OXYGENATED NITROGEN TO NITROGEN GAS. THE NITROGEN GAS IS THEN VENTED TO THE AIR.
- STEP 5:** STORMWATER PASSES INTO THE NEXT STORMWATER CELL FOR FURTHER AEROBIC AND/OR ANAEROBIC ACTIVITY AND CONVERSION.
- STEP 6:** TREATED STORMWATER WILL BE RELEASED IN A CONTROLLED MANNER THROUGH THE OUTLET CONTROL STRUCTURE. IF NEEDED, EXCESS STORMWATER WILL OVERFLOW THE BASIN VIA AN EMERGENCY SPILLWAY.
- OTHER:** THE BASIN IS LINED WITH AN IMPERMEABLE MEMBRANE TO PREVENT CONTACT WITH GROUNDWATER AND STORMWATER. A PERIMETER DRAIN WILL HELP ALLEVIATE HYDRAULIC PRESSURE ON THE LINER.

AN ACCESS ROAD WILL BE CONSTRUCTED AROUND A PORTION OF THE BASIN TO ALLOW FOR MAINTENANCE PURPOSES SUCH AS REMOVAL OF SEDIMENT AND HARVESTING / REPLACEMENT OF PLANT MATERIAL.



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**OYSTER POND BMP,
GRAVEL WETLAND**

Oyster Pond Furlong and
Absegami Run, Chatham MA

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**Figure
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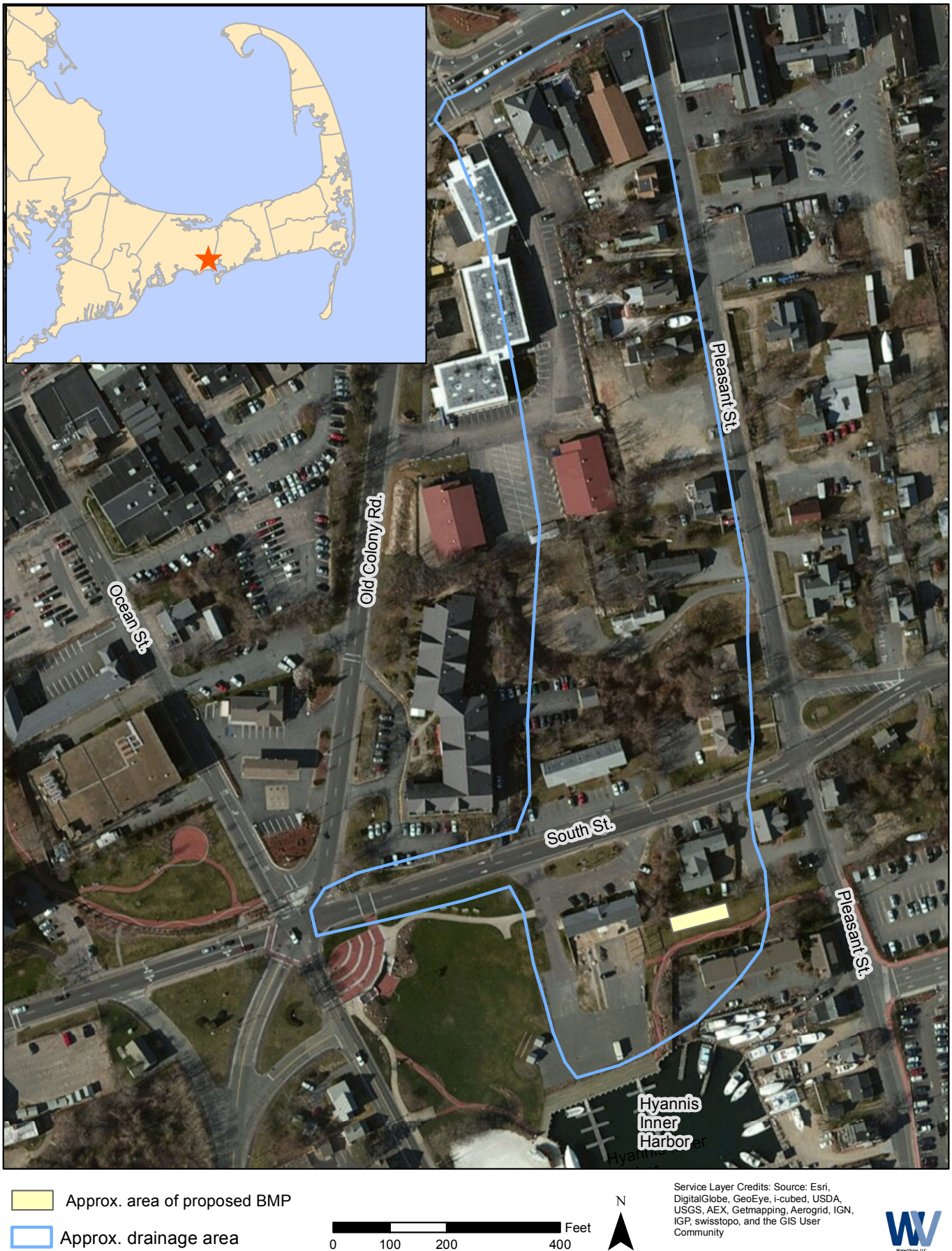
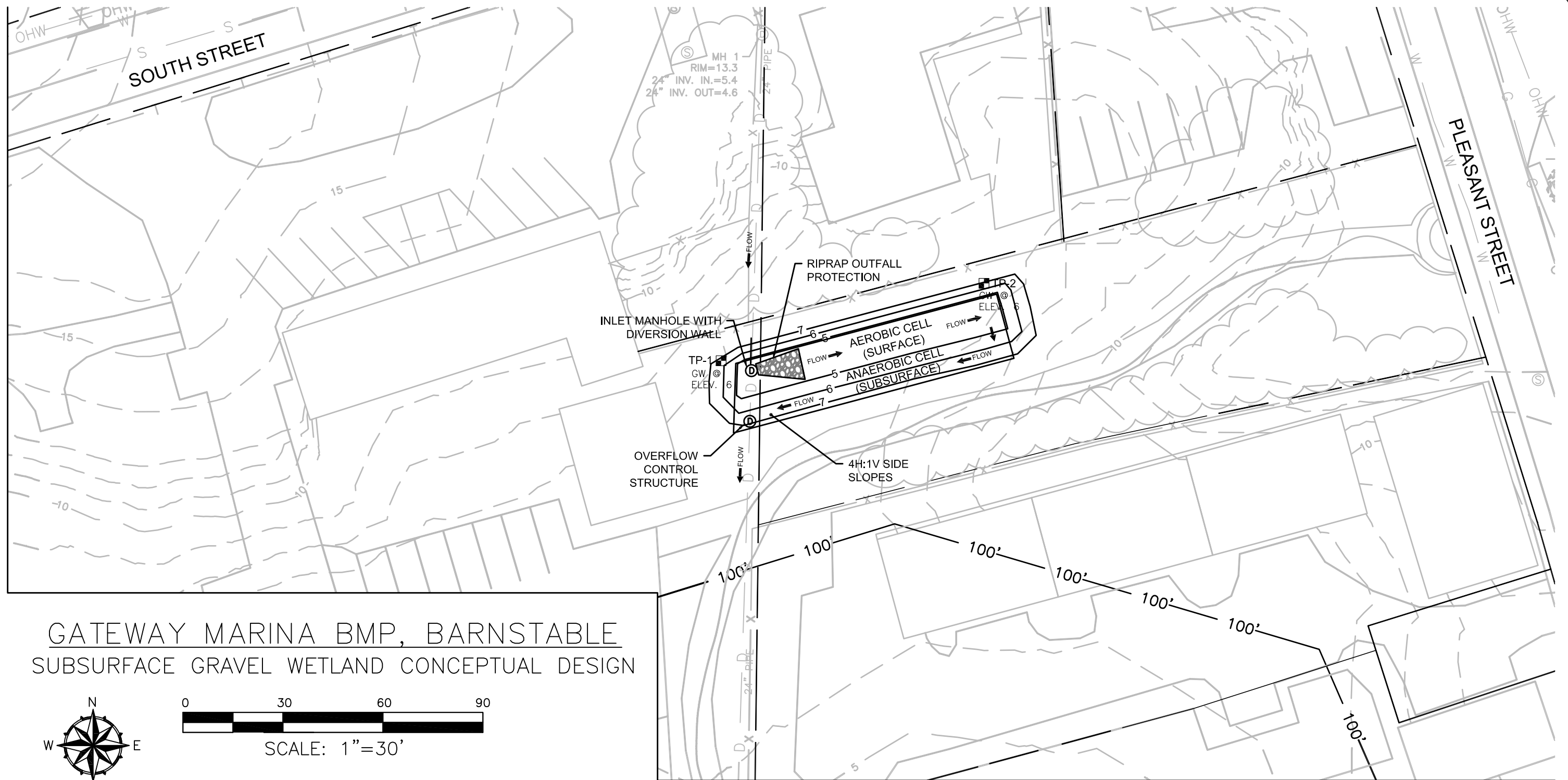
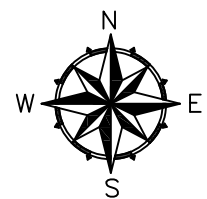


Figure 4. Potentially-suitable stormwater BMP site near Gateway Marina, Hyannis



GATEWAY MARINA BMP, BARNSTABLE SUBSURFACE GRAVEL WETLAND CONCEPTUAL DESIGN



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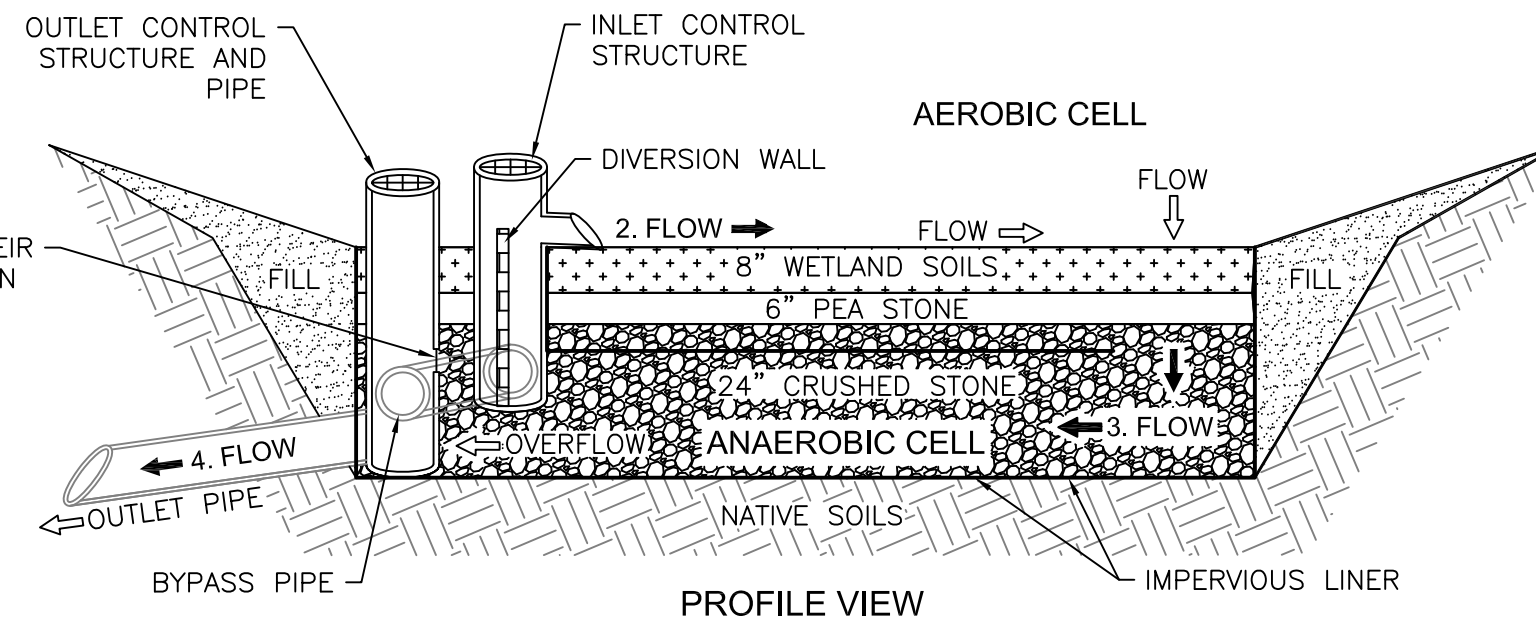
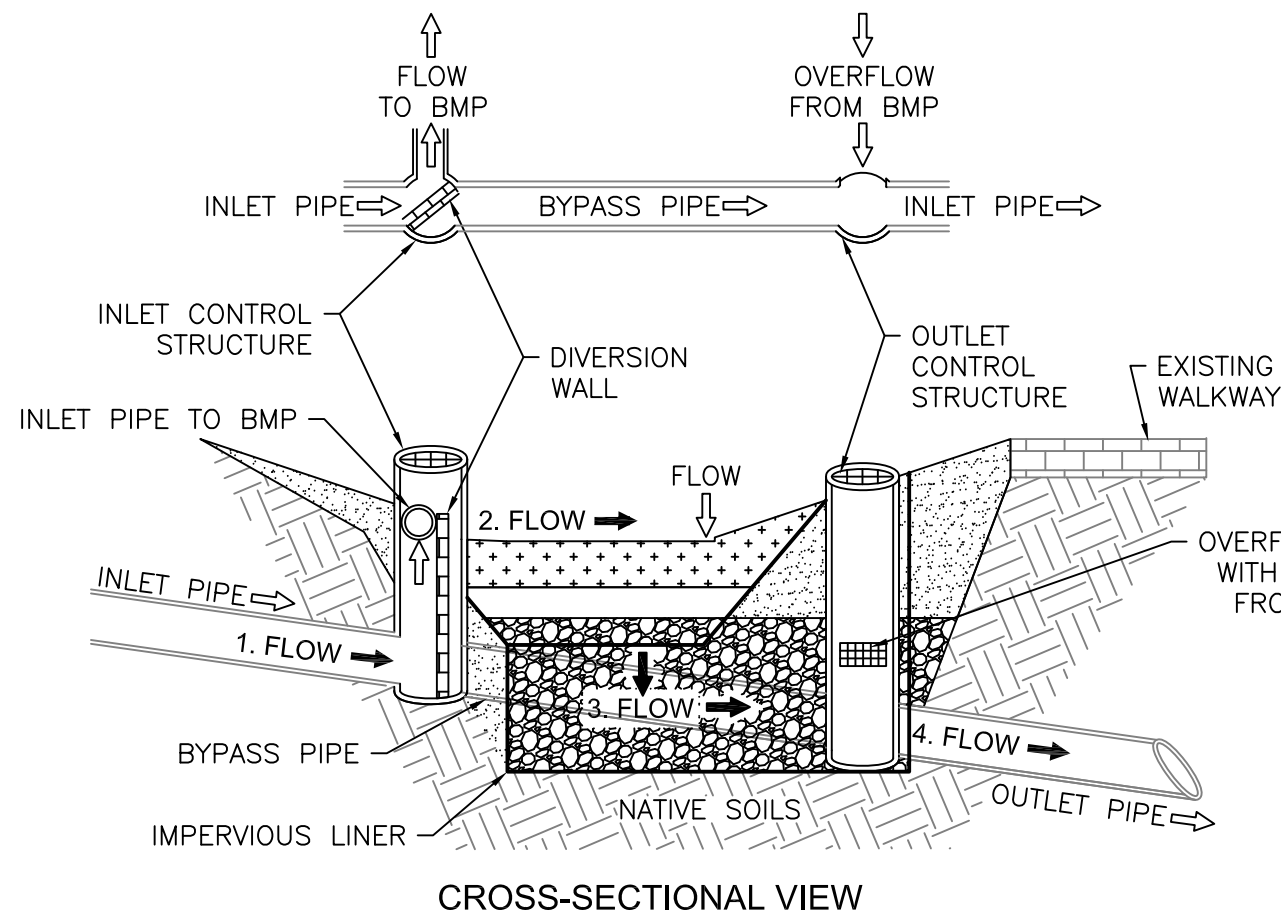
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GATEWAY MARINA BMP,
SUBSURFACE GRAVEL WETLAND
South Street and Pleasant
Street, Barnstable MA

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Figure
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GATEWAY MARINA BMP, BARNSTABLE SUBSURFACE GRAVEL WETLAND CONCEPTUAL DESIGN

STORMWATER TREATMENT PROCESS

- STEP 1:** A NEW DRAINAGE MANHOLE IS CONSTRUCTED IN LINE WITH THE EXISTING DRAINAGE TRUNK LINE, AND A DIVERSION WEIR IS CONSTRUCTED TO DIVERT SMALL STORMS INTO THE NEW STORMWATER BMP WHILE LARGER STORMS FLOW OVER THE WEIR INTO THE EXISTING DRAINAGE SYSTEM, BYPASSING THE BMP.
- STEP 2:** STORMWATER FLOWS Laterally INTO THE SURFACE GRAVEL WETLAND CELL WHERE STORMWATER IS EXPOSED TO AEROBIC BACTERIA FOR AEROBIC NITROGEN CONVERSION AND REMOVAL. PLANT MATTER PROVIDES FURTHER NUTRIENT UPTAKE THROUGH THE ROOT SYSTEMS.
- STEP 3:** STORMWATER MOVES PERCOLATES THROUGH THE PLANT ROOT SYSTEM AND IS CONVEYED TO AN UNDERLYING GRAVEL LAYER WHERE ANAEROBIC BACTERIA PROVIDE NUTRIENT REMOVAL VIA CONVERSION OF OXYGENATED NITROGEN TO NITROGEN GAS. THE NITROGEN GAS IS THEN VENTED TO THE AIR. AN IMPERMEABLE LINER SEPARATES THE TWO LAYERS.
- STEP 4:** TREATED STORMWATER WILL BE RELEASED IN A CONTROLLED MANNER THROUGH THE OUTLET CONTROL STRUCTURE. IF NEEDED, EXCESS STORMWATER WILL OVERFLOW THE BASIN VIA AN EMERGENCY SPILLWAY OVERFLOW FITTED ON TOP OF THE OUTLET STRUCTURE.
- OTHER:** THE BASIN IS LINED WITH AN IMPERMEABLE MEMBRANE TO PREVENT CONTACT WITH GROUNDWATER AND STORMWATER. A PERIMETER DRAIN WILL HELP ALLEVIATE HYDRAULIC PRESSURE ON THE LINER.



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**GATEWAY MARINA BMP,
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South Street and Pleasant
Street, Barnstable MA

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**Figure
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